International Low Temperature Plasma Community

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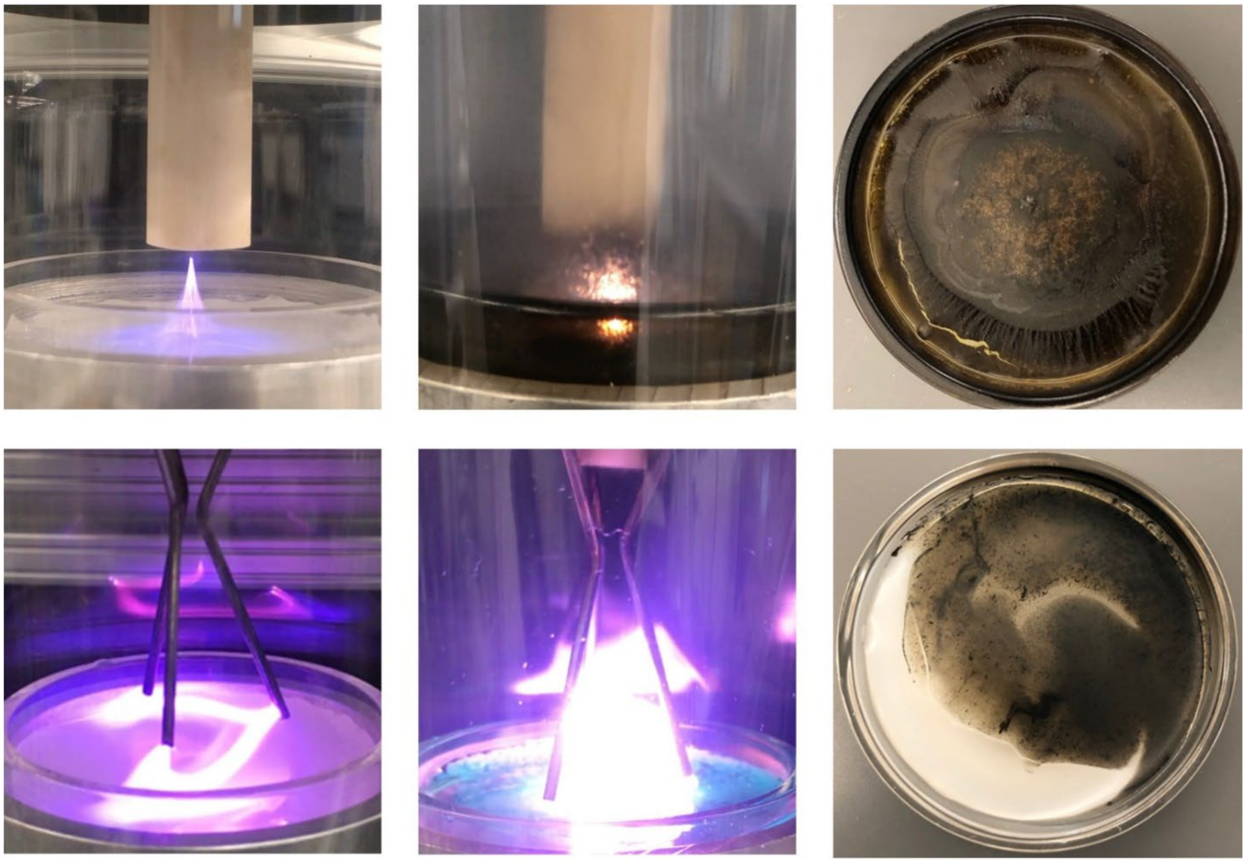
Newsletter 22

13 April 2022

Images to Excite and Inspire!

Please send your images (with a short description) to iltpc-central@umich.edu. The recommended image format is JPG or PNG; the minimum file width is 800 px.



Plasma Valorization of Plastics: More than 100 million tons of plastic films are produced globally every year, primarily for single-use packaging. These plastics are among the most challenging to recycle, upcycle, or biodegrade due to their inherent properties and relatively low value. Single-use plastic films are primarily made of low-density polyethylene (LDPE). Being long and branched chains of ethylene (C_2H_4), LDPE could be used to produce green hydrogen and carbon materials. The use of non-thermal or quasi-thermal plasma sources could lead to efficient approaches for the valorization of LDPE. The top row in the image shows: (left) the beginning of the treatment of a solid LDPE sample with an a ~ 25 kHz transferred-arc/spark discharge in nitrogen; (center) the reactor after 30 min of treatment depicting the formation of carbon deposits and the yellow glow of carbon emission; and (right) the carbonized top surface of the LDPE sample. The bottom row is a comparable sequence using an alternating-current gliding-arc discharge with tri-pronged electrodes: (left) beginning of the treatment; (center) during treatment showing bluish hue emission potentially signifying the formation of liquid hydrocarbons; and (right) the carbonized top surface of the sample. Despite the markedly different configuration of the reactors, their rate of hydrogen production per unit power is comparable, suggesting a dependency between the rate of hydrogen-bond breaking and plasma driving frequency.

Contact: **Prof. Juan Pablo Trelles**, University of Massachusetts Lowell, USA, Juan_Trelles@uml.edu.

In this issue:	
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Call for Contributions

Please submit content for the next issue of the Newsletter. Please send your contributions to iltpc-central@umich.edu by **May 13, 2022.**

Please send contributions as MS-Word files if possible – and **avoid sending contributions as PDF files**.

In particular, please send **Research Highlights and Breakthroughs** using this ***template:*** https://mipse.umich.edu/iltpc/highlight_template_v05.docx. The highlight consists of an image and up to 200 words of text; please also send your image as a separate file (the recommended image format is JPG or PNG; the minimum file width is 800 px). The topic can be anything you want - a recently published work, a new unpublished result, a proposed new area of research, company successes, anything LTP-related. Please see the *Research Highlights and Breakthroughs* for examples.

LTP Perspectives: Policy, Opportunities, Challenges

Two-Sided Perspectives: We are an intellectually diverse community with many opinions and many perspectives. The very important issues we face as a scientific community are not easily summarized by a single opinion or perspective. In this issue, we have one of a periodic series called the "Two-Sided Perspectives". Here we invite two leaders of the LTP field to provide their perspective on an important issue.

Please send suggestions for future topics for the *Two-Sided Perspectives* to iltpc-central@umich.edu. Please also feel free to suggest a colleague to provide one of the perspectives.

Double-Blind Reviewing of Journal Articles

Perspective 1: Prof. Hae June Lee

Occasionally, there has been bias in judging in the Olympic games where athletes were evaluated by different standards depending on the country they belong to. This angered many people who loved the spirit of sports. Similarly, when assessing scientific articles, there might be non-standard evaluations because of prejudice based on the authors' country of origin or organization. Do you think this possible? What will readers feel when articles with unsubstantiated claims are accepted without rigorous review because a famous laboratory submitted them? Both cases will produce severe distrust in the peer review system. When watching a movie, personal taste is used instead of scientific standards. We may choose to read articles based on personal preference. However, evaluating scientific papers or reports should be based on assessing creative and original achievements based on scientific evidence and logic. The criteria used for evaluation must be objective. From this point of view, a double-blind review has a significant advantage in maintaining objectivity to avoid bias.

However, the double-blind review sometimes has drawbacks. In most cases, the achievements of those who have devoted themselves to research in one field for a long time in science and technology are highly reliable. Thus, there is an expectation that they can be read with confidence, making it relatively easy to invite referees to review the articles submitted by experts. In addition, unethical data manipulation or inflating results could occur more frequently in the case of a double-blind review in which one's name is not immediately revealed to the referees. However, it still happens occasionally, even without double-blind reviewing. Considering the current situation with most journals, it is not easy to select appropriate reviewers to evaluate the submitted articles. The review process may be made more inconvenient by double-blind reviewing. However, it is believed that these practical difficulties can be solved by increasing the number of deputy editors or editorial board members of the journal. Even with double-blind reviewing, the deputy editors can see who submitted the articles while the referees do not know. That is to say, the drawbacks of double-blind review could be handled wisely by the editors.

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Perspective 2: Prof. Igor Adamovich

I understand the motivation for the double-blind refereeing of journal manuscripts, in pursuit of eliminating a possible bias that might affect the refereeing process. However, I think this is an overreaction to a legitimate concern. While attempting to remove bias, double-blind refereeing makes it extremely difficult to assess the credibility of the authors. In some cases, making significant advances in the field may require considering somewhat tentative, and perhaps even speculative, ideas and interpretations. If an author with a record of experience, excellence, and vision suggests such an interpretation, one may let the credibility of the author speak for itself and accept the interpretation as plausible. On the other hand, if a young researcher with limited experience and no track record suggests such an interpretation, one should naturally be more critical and skeptical in accepting it. Double-blind refereeing also encourages the authors to be more circumspect in describing their work, citing their previous publications, and placing the results in a wider perspective, to avoid being identified by the reviewers. Such obfuscation is contrary to the spirit of an open exchange of ideas, techniques, data, results, and interpretations.

A case in hand is a little-known story of a paper published in Journal of Chemical Physics over 50 years ago, *“Vibrational Relaxation of Anharmonic Oscillators with Exchange-Dominated Collisions”, by C.E. Treanor, J.W. Rich, and R.G. Rehm (J. Chem. Phys. 48 (1968) 1798,* https://doi.org/10.1063/1.1668914). This purely theoretical work predicted the existence of a strange nonequilibrium distribution of diatomic molecules over the vibrational energy levels, resulting in an absolute inversion at steady state. This manuscript was originally rejected by the journal, based on a strongly negative reviewer report which claimed that the main result (“the anharmonic V-V pumping”) violated the Second Law of Thermodynamics. The authors resubmitted the manuscript, along with a rebuttal. However, there was no experimental verification of the theoretical prediction at the time, which made conclusive demonstration of their validity difficult. The resubmitted manuscript was accepted, likely because one of the authors was an accomplished scientist, well known in the field. There is little doubt that the double-blind refereeing, where the track record of the authors is not a factor, would have resulted in another rejection. The rest is well known. The manuscript in question has become the seminal paper in the field of vibrational kinetics, the famous Treanor distribution has been demonstrated experimentally in 1971, and two of the authors have been nominated for the Nobel Prize in Chemistry in 1992.

I firmly believe that credibility and wisdom resulting from accumulated experience need to be acknowledged in the refereeing process, which is why I oppose the double-blind refereeing.

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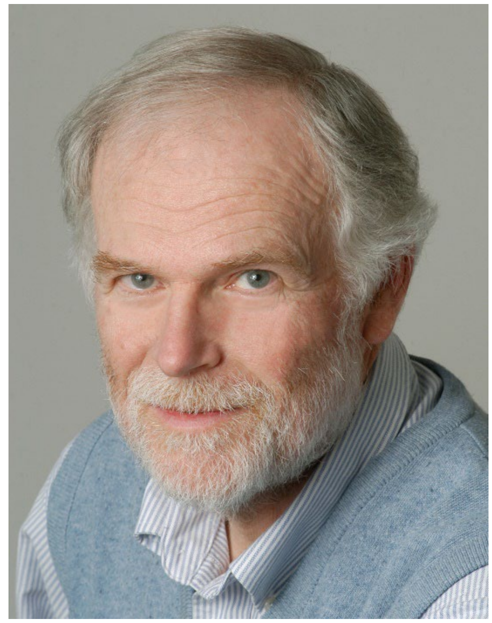
Prof. Michael Lieberman: Modern Plasma Device Theory and Simulations



Michael "Mike" Lieberman received the B.S. and M.S. degrees in Electrical Engineering from the Massachusetts Institute of Technology (MIT) in 1962, and the Ph.D. in Electrical Engineering from MIT in 1966. He joined the faculty at the University of California-Berkeley (UCB) in 1966. Mike is currently Professor Emeritus.

I first met Prof. Lieberman in 1986 when I was a graduate student in the introductory plasma theory course. Around 1990, he began seeking out simulation results that demonstrated some of his fundamental theoretical results for plasma sheaths, and we were very pleased at the remarkable agreement. The collaboration continued when Mike, Prof. Charles K. "Ned" Birdsall, and I developed a low temperature plasma device short course spanning theory and computation. We were beginning to build models of plasma devices, which included external driving circuits with complex impedance, multi-frequency and non-sinusoidal drive, with geometric features in planar or axisymmetric coordinates, including atomic and molecular collisions via a Monte Carlo model. Mike's theoretical insights were invaluable, and his ability to generalize and articulate foundational plasma concepts is unrivaled. Over 30+ years, we have co-advised many students, postdocs, and research scientists, by which I mean that I watched and learned from Mike as he distilled intricate theory and complicated simulation results into something understandable to the rest of us.

Mike has demonstrated a rare breadth in the field of plasmas, with exceptional depth in experiment, theory, and computation. Mike pioneered the spatially averaged global model for low temperature plasmas along with his key collaborators and students. This method has enabled the modeling of hundreds of species in thousands of reaction chains, enabling deep understanding of plasma chemistry and energetics. Mike's seminal works on DC and RF plasma sheath dynamics remains foundational to the bounded plasma field. With key collaborators, Mike also developed models of multifrequency capacitively coupled plasmas to understand how the ion energy flux and spectrum at a substrate could be controlled independently of the plasma density. He demonstrated the use of double layers to accelerate ion bunches, with use cases such as thrusters. Mike and coworkers also led the field in understanding electronegative discharges, and particularly the heating and sheath dynamics. His book on low temperature plasma devices, *Principles of Plasma Discharges and Materials Processing*, Wiley (1994, 2005) continues to educate new generations of plasma device engineers and physicists, setting the standard for the theory of bounded plasma devices from DC discharges to capacitively and inductively coupled discharges, electron-cyclotron resonance discharges, and many other configurations including temporal effects, models for spatial including plasma chemistry. This book is a compendium of many scholarly works developed over decades by Mike and others, masterfully put together so that a beginning graduate student can understand the existing models, and follow Mike's modeling process to extend the theory to new devices. That is really the most amazing aspect of Mike's contribution to the field: he has not only provided knowledge and explanation for key devices, but has also provided tools and a map for how to extend those models to new devices not yet conceived.

Commensurate with his many achievements, Mike is a fellow of the American Association for the Advancement of Science (AAAS, 1984), the American Physics Society (APS, 1980), American Vacuum Society (AVS, 2000), Institute of Electrical and Electronic Engineers (IEEE, 1994), and the International Plasma Chemistry Society (IPCS, 1980). In addition, he has received numerous awards, including Guggenheim Fellow (1972-3), the IEEE Marie Sklodowska-Curie Award (2020), the IEEE Nuclear and Plasma Sciences Society (NPSS) Plasma Science and Applications Committee (PSAC) Award (1995), the UC-Berkeley Distinguished Teaching Award (1971), the Von Engel Prize (2005), and the Will Allis Prize for the Study of Ionized Gases (2006).

For about a decade, I had the honor of sitting in the office between Mike and his close collaborator Allan Lichtenberg. They were so passionate about plasmas, that if one did not know they were the best of colleagues, one might be compelled to call the authorities for the practice of plasma physics which sounded like civil unrest. Mike even left an impression on the citizenry of Berkeley. One woman, after watching him walk into work and back each day for years no doubt in his signature train engineer's cap, blue jeans, and sandals, finally asked him when he was going to graduate. When Mike started doing simulations, he was so excited about the work that he would email me into the early hours of the morning to discuss our codes and the algorithms, working later than my graduate students. Mike is a gentleman and icon in the plasmas field who cares deeply about students and colleagues, and his seminal works continue to provide durable benefits for generations.

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General Interest Announcements

- **25th International Plasma School on "Low Temperature Plasma Physics: Basics and Applications", Bad Honnef, Germany**

We invite you to attend the **25th International Plasma School on "Low Temperature Plasma Physics: Basics and Applications"** (October 1-5, 2022) and its **Master Class "Electric Propulsion"** (October 6-8, 2022) in Bad Honnef (Germany). The school follows a long tradition of 23 editions in person and one online edition in the past. Last year we had to suspend the school, but this year the school will be held again in the physics center in Bad Honnef. We are confident that we can organize everything as intended, but will also plan generously for room occupancy to be prepared for any changes in the COVID-19 situation.

The enthusiastic support of many teachers and experts willing to give lectures at the Plasma School allowed us to compile, once more, a very promising program.

Information on the school and registration are available on the website: http://www.plasma-school.org.

We kindly ask you to save the date and to spread this information to your colleagues and/or students who might be interested.

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Meetings and Online Seminars

- **International Workshop on FAIR Data in Plasma Science**

  On May 16-18, 2022, the project *Quality assurance and linking of research data in plasma technology* - QPTDat will host the online event: **International Workshop on FAIR Data in Plasma Science**. The goal of the workshop is to intensify discussions about research data management and data standards in the plasma science community. The contributions range from results of the QPT-Dat project (first day) to the presentation of current activities in other projects in the field of plasma science that strive for data and software sustainability, such as LXCat and PlasmaFAIR (second day). Finally, overarching initiatives such as the Open Research Knowledge Graph and the Patents4Science project illustrate how data and information from different sources can be linked together to make them more accessible for science (third day). We look forward to exciting presentations and stimulating discussion with all sides.

  Participation in the workshop is free and only possible with prior registration on the website: https://www.plasma-mds.org/ws-fair-data-plasma-science.html. Registered persons will receive further information about participation in the virtual event a few days before the workshop starts.

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- **75th Annual Gaseous Electronic Conference and 11th International Conference on Reactive Plasmas, Sendai, Japan**

  SAVE THE DATE: The 75th Annual Gaseous Electronic Conference is excited to announce it will be held jointly with the 11th International Conference on Reactive Plasmas on October 3 - 7, 2022, in Sendai, Japan.

  Abstract submission and travel grant information can be found at:
  http://www.apsgec.org/gec2022/index.php

  Invited Speaker Highlights:

  Instabilities and Turbulent Processes in Low-Temperature Magnetized Plasmas
  Prof. Kentaro Hara, Stanford University

  Machine Learning Plasma-Surface Interactions: From Low to High Fidelity Surrogate Models
  Prof. Jan Trieschmann: Brandenburg University of Technology

  Development of Validated Fluorocarbon Plasma Chemistry for Multi-Dimensional Modeling of Semiconductor Plasma Etch Processes
  Dr. Dmitry Levko, Esgee Technologies Inc.

  Contact:
  Prof. Toshiro Kaneko
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- **9th Central European Symposium on Plasma Chemistry CESPC-9, Vysoke Tatry, Slovakia**

We cordially invite you to attend the **9th Central European Symposium on Plasma Chemistry (CESPC-9,** http://www.cespc9.eu/), September 4-9, 2022, in the north of Slovakia. CESPC is a well-established small size symposium of <120 participants and friendly open atmosphere. It deals with fundamental problems of gaseous plasma physics and chemistry, modelling and diagnostics, new and nanostructured materials, energy technologies, environmental protection, surface processes, and plasma technologies in modern industry, medicine, food technology, and agriculture. It provides as an interactive platform enabling researchers of different backgrounds (chemistry, physics, engineering, material sciences, biology, medicine, agriculture, food technology) to meet and develop new ideas in the widely interdisciplinary field of plasma chemistry. The symposium promotes the transfer of scientific knowledge to industrial, agricultural, and clinical practices.

This time, CESPC-9 will be joint with **COST Action CA19110 Plasma Applications for Smart and Sustainable Agriculture – PlAgri** (https://plagri.eu/) workshop of working groups 2 (seeds), 3 (plants), 4 (agriculture wastewater and plasma activated water), and 5 (food industry).

The PlAgri Action aims to investigate the potential of low-temperature plasmas as a green alternative for treating seeds, plants, agricultural wastewater, plant growth media, manure, and the use of plasmas for treating food and packaging. It also studies undergoing processes of plasma treatment of this agricultural biological materials. The Action aims to a new dimension in sustainable agriculture with lower chemical and environmental impact, higher yield, and sustainability.

Registration open: http://www.cespc9.eu/index.php?link=05_reg_form.php

Abstract submission open until **30 April 2022**: http://cespc9.eu/index.php?link=sign_in.php&info=3

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- **Online Seminars – OLTP and IOPS**

The *Online Low Temperature Plasma* (OLTP) seminar series and the *International Online Plasma Seminar* (IOPS) are continuing to provide the international community with regular opportunities to hear from leading researchers in the field.

  - The program of the OLTP (and links to past seminars) can be found at:
    https://theory.pppl.gov/news/seminars.php?scid=17&n=oltp-seminar-series

    Dr. Anne Bourdon and **Dr. Igor Kaganovich**, OLTP Co-Chairs
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  - The program of the IOPS (and links to past seminars) can be found at:
    http://www.apsgec.org/main/iops.php.

    Dr. Kallol Bera, IOPS Chair, kallol_bera@amat.com

Community Initiatives and Special Issues

- **Request for Input for US Office of Science and Technology Policy (OSTP) Statement on "Sustainable Chemistry"**

  The US Office of Science and Technology Policy (OSTP) is requesting input on sustainable chemistry to guide future US government efforts. The guidance provided by OSTP will be used by US Federal agencies to develop programs and to fund research. The term "sustainable chemistry" does not have a consensus definition and most uses of the term indicate that it is synonymous with "green chemistry." Therefore, information is requested on the preferred definition for sustainable chemistry. This is a very important opportunity for both the US and international LTP communities to define the role of plasmas in sustainable chemistry.

  More information and directions for providing your own input is at this link:

  https://www.federalregister.gov/documents/2022/04/04/2022-07043/request-for-information-sustainable-chemistry?utm_medium=email&utm_source=FYI&dm_i=1ZJN,7T47T,PX784F,VV00Z,1

  We are planning a community response to this request. If you would like to contribute to the community response, please send no more than 1 page of text in an MS-Word document to iltpc-central@umich.edu. In the document, please include your contact information, at most 1 figure, and at most 5 references. This input will be combined into a document that will be about 5-6 pages long. So please be direct in your comments.

  Please also indicate in your email if you would like to help develop the final document and/or review the document prior to submission.

  Please send your contributions no later than **15 May 2022**. The deadline for comments to be submitted to OSTP is **3 June 2022**.

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The Effect of Air Plasma Activated Liquid on Uropathogenic Bacteria

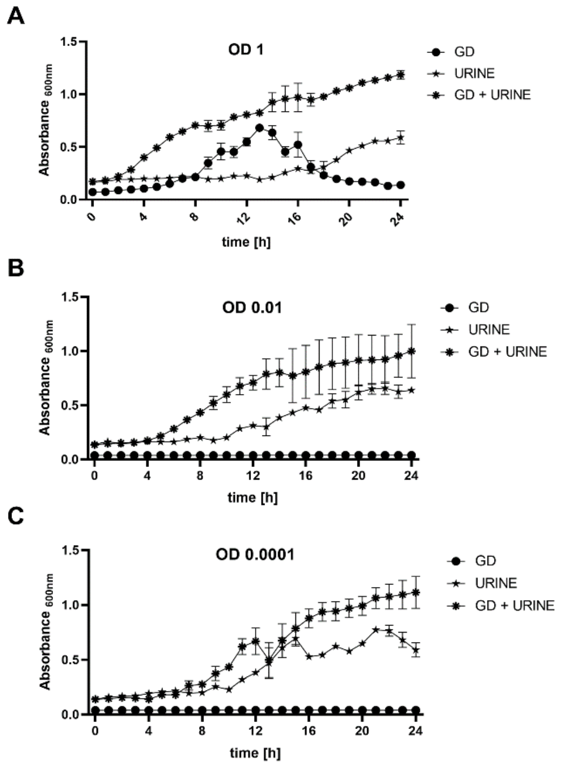

Figure 1. Antimicrobial effect of Glow discharge PAL, urine and mixture of GD PAL and urine on different concentrations of uropathogenic *E. coli*: a) OD 1 = 8×10^8 CFU/ml, b) OD 0.01 = 8×10^6 CFU/ml, c) OD 0.0001 = 8×10^4 CFU/ml.

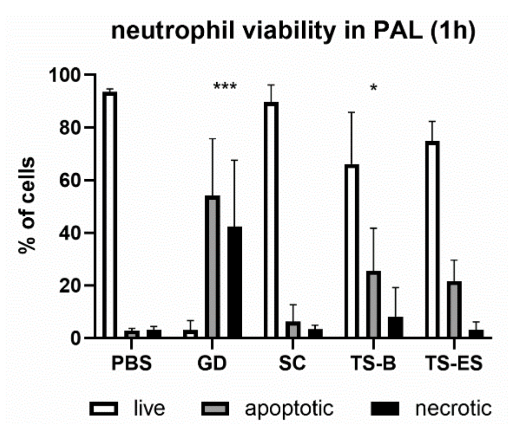

Figure 2. Neutrophil viability in 4 studied types of PAL after 1-hour incubation.

Urinary tract infections (UTI) are often caused by resistant uropathogenic bacteria and can lead to sepsis or chronic renal failure. Cold plasma activated liquid (PAL) has known antimicrobial properties with applications in wound disinfection. The aim of our study is to evaluate PAL as a potential treatment of UTI in an animal model. Based on *in vitro* tests using a uropathogenic *E. coli* strain, PAL generated in the atmospheric air Glow Discharge plasma had the strongest antimicrobial effect in comparison to other types of PAL and was further tested *in vivo*. Transurethral PAL application had no effect on bacterial load in the 24 h mouse model of UTI. Upon investigating the treatment failure, we found that urine completely prevented any antimicrobial effects of PAL and PAL treatment of neutrophils resulted in their reduced viability and loss of mitochondrial membrane potential. These results do not support the hypothesis that the *in vitro* antimicrobial effects of PAL can be translated to the *in vivo* model of UTI. This could be explained by the attenuating effect of urine on the antimicrobial activity of PAL and its toxicity on immune cells. The detailed mechanism of the effects of urine on PAL requires further investigation.

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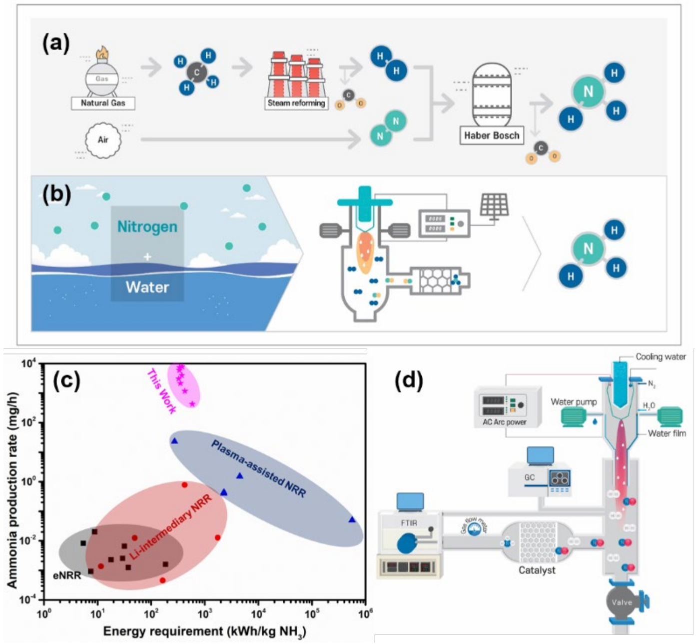
Source:
Plasma Chemistry and Plasma Processing (2022)
https://doi.org/10.1007/s11090-022-10239-1

Sustainable Ammonia Production Using Plasma Catalyst-Integrated System from Water and Nitrogen



Schematics illustrating the **(a)** Haber–Bosch process and **(b)** the proposed novel plasma catalyst-integrated system for ammonia (NH_3) synthesis. Here, rotating gliding arc (RGA) plasma is used to produce hydrogen gas (H_2) and nitric oxide (NO) from water (H_2O) and nitrogen gas (N_2); NO is reduced by H_2 to form NH_3 via catalytic reduction. **(c)** NH_3 production rate and energy consumption compared with recently reported state-of-the-art results. **(d)** Schematic of the proposed plasma catalyst-integrated system for highly selective NH_3 production with Fourier-transform infrared spectroscopy (FTIR).

In this paper, we present a plasma catalyst-integrated system for sustainable ammonia production, which can facilitate massive, localized ammonia production. This study demonstrates the single-step co-generation of hydrogen and nitric oxides (NO_x) from H_2O in the nitrogen discharge used for ammonia production, which proceeded via the catalytic reduction of NOx by hydrogen gas.

More than 99% of the NO_x produced by this plasma reaction becomes nitrogen monoxide, which can be easily reduced to ammonia. The nitrogen monoxide then reacts to the co-produced hydrogen to produce ammonia with over 95% of high selectivity, and the heat generated during the plasma decomposition process is used for the catalytic synthesis process.

The proposed plasma technique yields higher NO_x and hydrogen concentrations than conventional plasma methods, which were used to obtain an ammonia concentration of ~0.84% with a selectivity of ~95% and a production rate of 120 μmol/s. Compared with previous studies on ammonia synthesis from nitrogen, the remarkable ammonia yield (300–400-fold higher). These promising results provide a breakthrough in the transition toward sustainable and environmentally friendly ammonia production.

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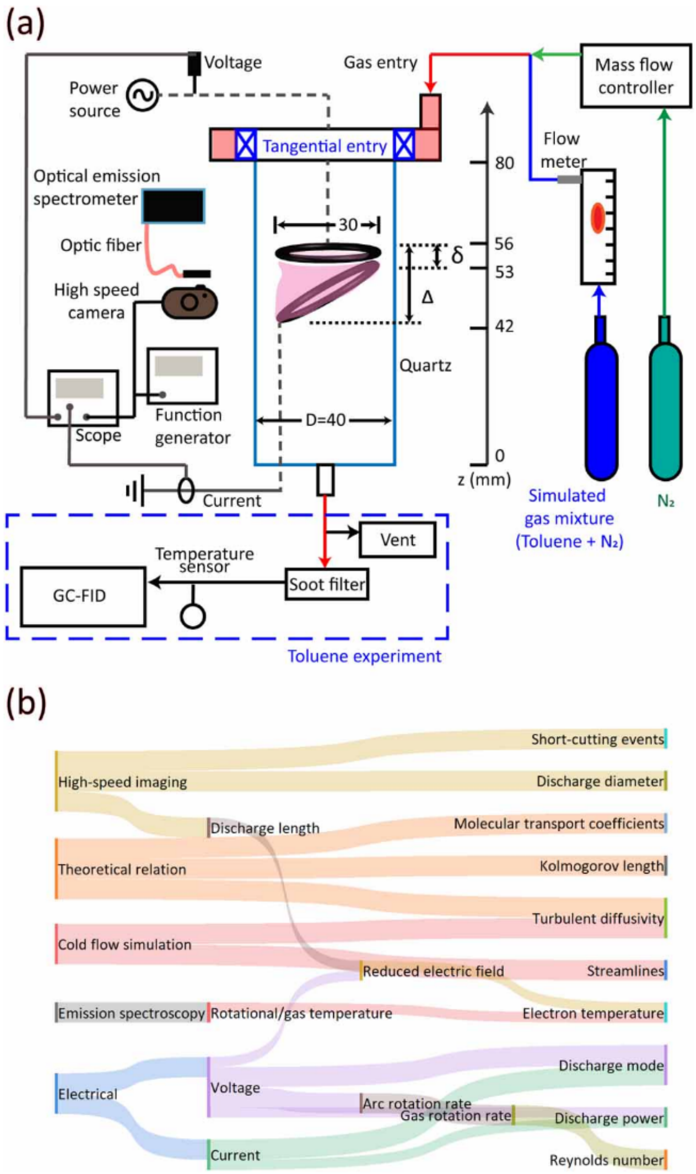
Source: ACS Energy Letters **6**, 8, 3004–3010 (2021).

https://doi.org/10.1021/acsenergylett.1c01497

More information:
https://www.plasmascholar.com/

Influence of Transitional and Turbulent Flow on Electrical, Optical, Morphological and Chemical Characteristics of a Nitrogen Rotating Gliding Arcs



(a) Schematic of RGA reactor and diagnostic setup; all dimensions are in mm. **(b)** Schematic flow from diagnostic/simulation tools to the analyzed parameters.

This work reports the effect of flow regime on plasma characteristics of an atmospheric N_2 rotating gliding arc (RGA). When changed from transitional (5 SLPM) to turbulent (50 SLPM) flow, operation mode transitioned from glow to spark discharge due to frequent reignition events. The average reduced electric field (E/N) and electron temperature raised (38→92 Td, 0.84→2.2 eV); and gas temperature (T_g) slightly cooled (2973→2807 K). Molecules generated for 100 eV of energy input (G–factor) increased by a factor of 20 and 65, for the chemically active singlet and triplet metastable states of N_2, respectively—a promising feature for chemical applications. A sudden three-fold increase in the energy efficiency, achieving a destruction of 3.0 ± 0.2 $g \cdot kWh^{-1}$ of dilute toluene (112 ± 10 ppmV) at highly turbulent flow corroborated the enhancement of the G–factor, E/N and T_g; and indicated the sensitivity of plasma properties to the flow regime. Interestingly, for flows having Reynolds number $\geqslant 3 \times 10^4$, the bandhead of N_2^+ shifted from 0–0 at 391.4 nm to 3–3 at 383.3 nm attributed to higher-level perturbations, showing again the sensitivity. The smallest eddies ($\eta \approx 6$ μm) are less than the discharge diameter ($d_d \approx 220 \pm 90$ μm), and thermal/mass Péclet number >1. The eddies of size $\leqslant d_d$ advected the plasma species, wrinkled/distorted the discharge, and increased the reignition events, eventually affected the plasma properties including the chemical performance (energy efficiency).

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Source:
J. Phys. D: Appl. Phys. **55,** 245202 (2022)
https://doi.org/10.1088/1361-6463/ac5bcc

Charged Particle Kinetics and Gas Heating in CO_2 Microwave Plasma Contraction

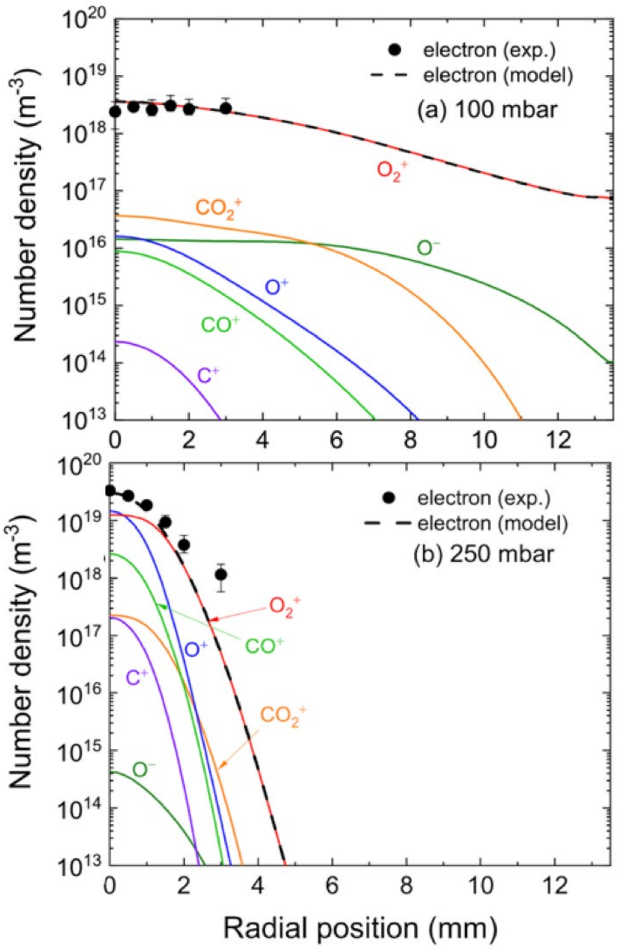

Figure 1. Measured (dots) electron number density and calculated (lines) electrons and ions number density, at (a) 100 mbar and (b) 250 mbar.

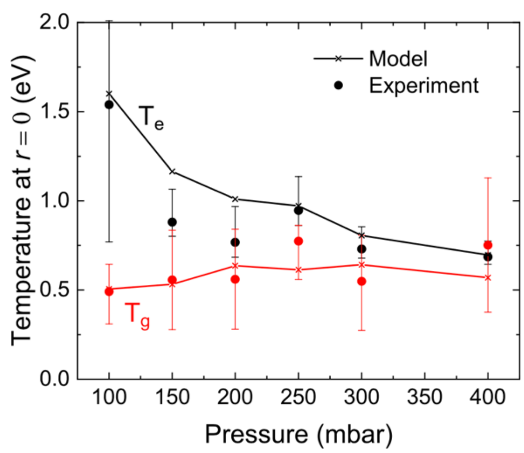

Figure 2. Measured (dots) and calculated (lines) electron temperature (black) and gas temperature (red) in the center of the plasma, as a function of pressure.

Microwave (MW) plasmas are promising for efficient CO_2 dissociation for the production of carbon-neutral fuels. The optimal condition for these MW reactors has shown strong correlation with discharge contraction. However, this mechanism is not fully understood due to the complex interplay of many effects, namely transport of reactive flows, complex chemistry, and electromagnetic fields.

In this work, a 1-D radial fluid model including neutral, electron and ion kinetics, and gas temperature has been developed. The model is coupled to a Monte Carlo Flux code for simulations of electrons. Results of the model are compared with spatially resolved measurements of main neutral species mole fractions, electron number density, gas and electron temperature. We have found that, as pressure is raised, the inhomogeneous gas heating induces significant gradients in neutral and charged species mole fractions profiles. Moreover, the transition from diffuse to contracted plasma is accompanied by a change in the dominant charged species. Associative ionization increases in the plasma core, leading to an increase of peak electron number density and a decrease of electron temperature with pressure that favors radial plasma contraction. These results are important for future developments of plasma chemistry models validated against experiments and for the characterization of CO_2 MW plasma sources.

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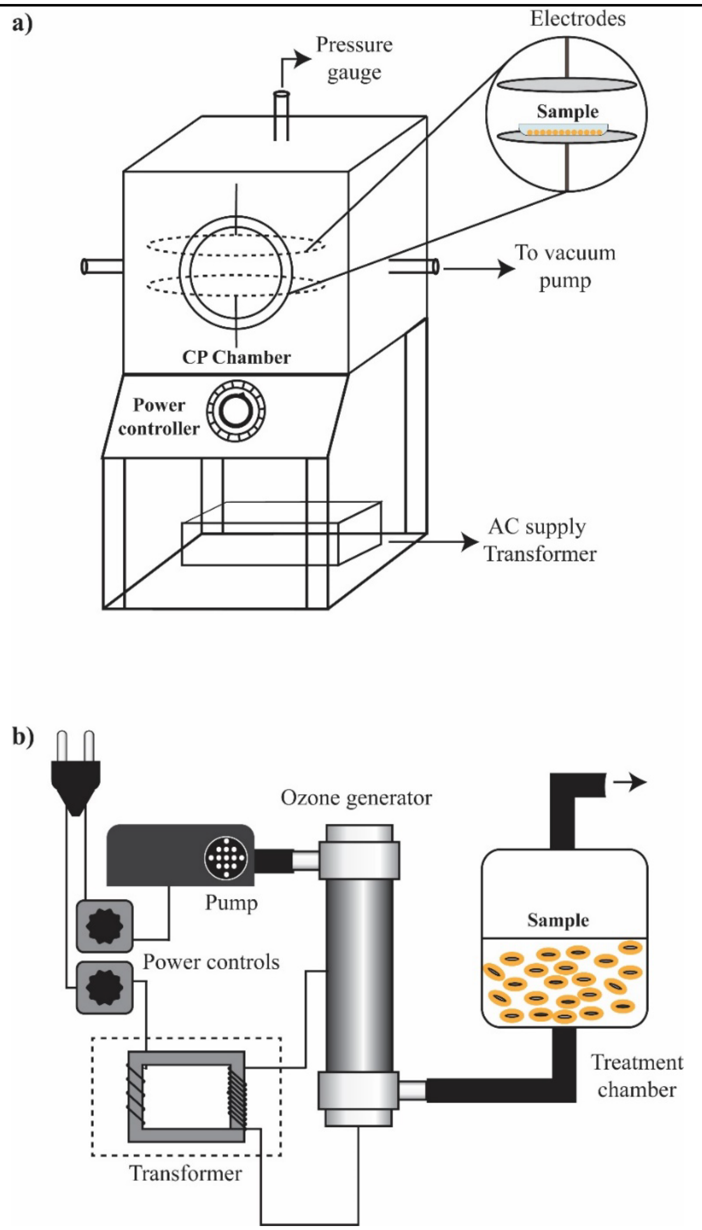
Source:
L. Vialetto, A. W. van de Steeg, P. Viegas, S. Longo, G. J. van Rooij, M. C. M. van de Sanden, J. van Dijk, and P. Diomede, Plasma Sources Sci. Technol. https://doi.org/10.1088/1361-6595/ac56c5

Chlorpyrifos Pesticide Reduction in Soybean Using Cold Plasma and Ozone Treatments



Experimental set-up: **a)** Cold plasma unit; **b)** Ozone generation unit.

To meet market demands, soybean is predominantly grown with the excess use of harmful pesticides like chlorpyrifos, which leaves poisonous residues on the seeds' surfaces. In this study, we have treated chlorpyrifos (1, 2 and 3 mg/kg) infused soybean with ozone (300 to 550 mg/l) and low pressure (2 mbar) cold plasma (CP: 1.0 to 2.0 kV) for up to a period of 30 min to reduce the pesticide residues. However, it was found that at higher pesticide concentrations, ozone treatment can only cause 50% pesticide reduction after 30 min exposure, even at 550 mg/l concentration. In contrast, CP treatment took only 6 min to achieve the same at 2.0 kV voltage level but caused a significant reduction ($P \leq 0.05$) in moisture content and seed coat integrity. However, the water absorption of CP treated samples was higher (~230%) than ozone-treated samples (~200%). Furthermore, increased pesticide concentration reduced the pesticide degradation rate for ozone (0.078 to 0.0643 min-1) and cold plasma (0.160 to 0.143 min-1) treatments even at higher treatment intensities. Nevertheless, CP was effective against chlorpyrifos than ozone treatment and caused minor quality changes in soybeans.

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Source:
LWT - Food Science and Technology **159** (2022) 113193. https://doi.org/10.1016/j.lwt.2022.113193.

New Resources

Please submit your announcement for New Resources to iltpc-central@umich.edu.

Career Opportunities

- **Postdoctoral Appointee in Advanced Plasma Diagnostics Sandia National Laboratories Low-Temperature Plasma Research Facility, Livermore, CA, USA**

  We seek a motivated postdoctoral experimentalist to join a multidisciplinary team of researchers in studying low-temperature plasmas and plasma-assisted chemistry at Sandia National Laboratories Low-Temperature Plasma Research Facility, Livermore, CA, USA. The position will focus on the development and application of laser diagnostics that will be coupled with mass spectrometry to probe fundamental processes in plasmas.

  - Work as part of a team of experts in plasmas, optical diagnostics and spectroscopy, combustion, catalysis, mass spectrometry, kinetics and dynamics of chemical reactions.
  - Conduct research under the mentorship of technical staff at the Livermore, California site of Sandia's Low-Temperature Plasma Research Facility (www.sandia.gov/prf).
  - Work with collaborating researchers from the international plasma research community.
  - Present results at national and international conferences and publish in high-profile peer-reviewed journals.

  Required qualifications:

  - PhD in a physical science or engineering field.
  - Significant experimental research experience in low-temperature plasmas and/or laser diagnostics.

  Desired qualifications:

  - Background combining elements of the following: plasma physics, optical diagnostics, reacting flows, catalysis, gas-phase chemistry, surface chemistry, molecular spectroscopy and energy transfer, mass spectrometry.
  - Experience with a range of low-temperature plasma sources.
  - Experience with LIF, Thomson scattering, EFISH, Raman scattering, CARS, photoionization mass spectrometry.
  - Strong analytical and interpersonal skills.
  - Ability to work effectively within a multidisciplinary research team.
  - Record of publications in peer-reviewed journals and presentations at scientific conferences.

  See Sandia Careers Website for full details:
  https://cg.sandia.gov/psc/applicant/EMPLOYEE/HRMS/c/HRS_HRAM_FL.HRS_CG_SEARCH_FL.GBL?FOCUS=Applicant&Page=HRS_APP_JBPST&Action=U&FOCUS=Applicant&SiteID=1&JobOpeningId=682030&PostingSeq=1

  Contact:
  Dr. Jonathan Frank
  Sandia National Laboratory, USA
  jhfrank@sandia.gov

- **Post-doctoral Researcher, Plasma Matching Networks, University of Toledo, USA**

  An immediate post-doctoral research position is available in the Adaptive Radiofrequency and Plasma Lab (ARPL) at the University of Toledo (https://www.semnani-arpl.com/) in Toledo, Ohio, USA. The post-doctoral associate will perform research in wideband plasma impedance matching networks. The successful candidate will have opportunities to develop research and scholarly programs with academic/industry partners and graduate/undergraduate students. This post-doctoral research associate will primarily be engaged with the

theory and implementation of wideband matching networks using plasma technology. However, she/he will also have a chance to work with students and get involved in other research projects in the group. The initial appointment will be for one year but can be renewed upon mutual agreement. For more information and application instructions, see:
https://careers.utoledo.edu/cw/en-us/job/493266/postdoctoral-research-associate-electrical-engineering.
Questions should be directed to Prof. Semnani.

Contact:
Prof. Abbas Semnani
University of Toledo, USA
Abbas.Semnani@UToledo.edu

- **Post-Doctoral Researcher, Microfluidics and Plasma Catalysis, New York University, USA**

The Hartman Research Laboratory (https://wp.nyu.edu/hartmanlab/) at the New York University (NYU) Tandon School of Engineering in the Department of Chemical and Biomolecular Engineering is seeking to hire a Postdoctoral Associate to join an exciting project on microfluidic synthesis of materials in energy science. NYU is one of the top private research universities in the world, and the Tandon School of Engineering, the second oldest school of engineering in the USA, has the distinct history of having been known previously as Brooklyn Polytechnic and the NYU Polytechnic School of Engineering.

The project involves reaction engineering for plasma catalysis, *in-situ* characterizations, and the development of first-principle models. Candidates will be responsible for appointment to a multi-institution, collaborative project and perform work in a multidisciplinary environment.

Tandon faculty and students are at the forefront of the fastest growing tech hub in the nation and have access to NYU's Global Network University. The NYU Tandon School of Engineering is deeply committed to excellence in teaching and learning. Tandon fosters student and faculty innovation and entrepreneurship that make a difference in the world.

This is a one-year appointment, starting as early as April 1, 2022, with one year planned renewal contingent on performance and continued funding.

Qualified candidate should have experience with the design of microfluidics, fabrication using cleanroom facilities, and their application with analytical techniques are required. Proficiency in computer programming and computational fluid dynamics simulations are also required. The successful candidate will be driven, creative, and team-oriented with a passion for discovery. We are seeking individuals with a strong background in chemical engineering and/or related field. We welcome applicants from recent PhDs and individuals seeking additional postdoctoral training. Eligible candidates will be required to present eligibility to work in the United States.

Applicants should submit a cover letter, curriculum vitae, pdfs of three relevant journal articles, and a list of three references with complete contact information: https://apply.interfolio.com/104218.

Contact:
Prof. Ryan L. Hartman
NYU Tandon School of Engineering, USA
ryan.hartman@nyu.edu

- **Post-doctoral Research Fellow – Plasma-Liquid Modeling, James Cook University, Australia**

  The Post-doctoral Research Fellow will work with **Prof. Ron White** at James Cook University – JCU (Australia) and undertake research focused on electron and positron transport processes in liquids, including modelling of plasma-liquid interactions. Working in collaboration with the Head, Physical Sciences' research group, the Postdoctoral Research Fellow will conduct research, develop and/or contribute to research publications as a member of a high performing team and ensure all key research outcomes and milestones are achieved in alignment with project timelines.

  The ambition to establish a strong research portfolio in non-equilibrium transport processes for medical and technical applications, as well as a demonstrated capacity to contribute to the growth of a research team and the University's Physical Sciences group are also inherent to the requirements of the position.

  Principle duties:
  - Contribute to the development of theoretical and computational models of electrons, positrons and plasma discharges interacting with liquids.
  - Collaborate with experimentalists, students and other key stakeholders involved in the project.
  - Publication of research findings in high quality journals.
  - Collaborate with other researchers and students, including provision of provide guidance to post-graduate students.
  - Contribute to the Physical Sciences group through participation in activities as directed.
  - Enhance the visibility and reputation of JCU through active participation in public outreach activities as an individual and through participation in events organized by JCU.

  Requirements:
  - A PhD qualification or equivalent in Physics, or a closely related field.
  - Demonstrated experience in a field, or fields, of physics or applied mathematics, such as but not limited to plasma discharge modelling, fluid dynamics or statistical mechanics.
  - A proven track record in research publication.
  - Demonstrated ability to efficiently organize and conduct research projects.
  - Effective written, oral communication and interpersonal skills.
  - Experience in working effectively in teams, and the ability to engage with industry, community agencies and professional bodies.

  For more information and application instructions contact Prof. White.

  Contact:
  Prof. Ron White
  James Cook University, Australia
  ronald.white@jcu.edu.au

- **Computational RF and Plasma Engineering, Lam Research, Fremont, California, USA**

  We are searching for a talented computational RF and plasma engineer with a strong background in computational physics and engineering to join our team. As a key team member, you will support product design guidance through computational modeling of physical phenomena in plasma processing reactors involving highly selective etch processes. This is a perfect role for candidates who love to work on real-world applied research in low temperature plasma modeling on state-of-the-art challenges in semiconductor fabrication. Your work will have a direct impact on plasma chamber and process design for current and future technology nodes.

Essential functions and skills/abilities:

- Knowledge of plasma physics, semiconductor process technology, design, and manufacturing.
- Provide product design guidance through computational modeling and simulation of multi-physics phenomena involving plasma, RF, electromagnetics, flow, heat, and chemistry.
- Expertise in plasma modeling and platforms (HPEM / nonPDPsim / Vizglow / ACE+), problem setup, optimization, troubleshooting for both ICP and CCP systems.
- Expertise in FVM / FEM platforms (openFOAM / ACE+ / Fluent, Comsol, Maxwell/HFSS) for flow, chemistry, thermal, structural, electromagnetics and related meshing techniques.
- Familiarity with molecular dynamics (LAMMPS) and interatomic potential development.
- Proficiency in modeling & simulation, computational sciences, numerical methods and optimization.
- Experience in programming with Fortran/ C/ C++, Python, Matlab, and related SW tools/compilers.
- Ability to quickly learn and master new software tools is desirable.
- Contribute to engineering design, process, hardware, and software testing to solve product issues and interface in complex cross-functional teams.

Requirements:

MS/PhD Physics/Chemistry/ Engineering – Chemical, Electrical, Mechanical, or related field.
Demonstrated experience or background in:

- Plasma science & technology.
- Computational sciences, plasma physics, electromagnetics, transport phenomena.
- Design of experiments.
- Programming and numerical methods.

Interested candidates can apply at: https://careers.lamresearch.com/job/Fremont-RF-C%26F-Engineer-4-CA-94538/855964600/

Contact:
Dr. Saravanapriyan Sriraman
Lam Research Corp., USA
Saravanapriyan.Sriraman@lamresearch.com

- **Research Fellow in Theoretical Molecular/Plasma Physics, University College London, Physics and Astronomy, UK**

The project aims to develop the capability to perform full collisional-radiative modeling of technological plasmas exploiting data provided by the (radiative) ExoMol database and the (collisional) QDB database; software to exploit these data will also be developed by the researcher appointed. The project involves working with **Prof. Jonathan Tennyson** and is being undertaken in collaboration with UCL spin-out Quantemol, Ltd who are likely to offer employment on successful completion of the work. This position is funded for 1 year in the first instance.

Further details and the application procedure:
https://tinyurl.com/UCLPAjob

Contact:
Anna Dzarasova
Quantemol, Ltd, London, UK
anna@quantemol.com

- **Modeling Engineer, Plasma Reactor Systems for Wafer Fabrication, Lam Research, Tualatin, Oregon, USA**

  Job responsibilities:
  - Formulate models of plasma reactor systems for wafer fabrication.
  - Work with process and hardware design engineers to model and simulate Multiphysics problems involving plasmas, heat and mass transfer, electromagnetics at the reactor level as well as wafer level.
  - Find root-causes, optimize process and hardware design with the aid of a combination of simulation and modeling tools.
  - Simplify complex phenomena into solvable models that capture the essence of the physics.
  - Take the initiative to address the limitations in full scale plasma simulation when needed, and adopt numerical methods that speed up/augment the physics based models.
  - Design experiments to validate and refine the current models based on tool and wafer measurements.
  - Communicate findings to a larger multidisciplinary audience.
  - Provide innovative, impactful and scalable solutions to hardware and process challenges with the aid of simulations.
  - Put in place modeling and simulation methods and guidelines for plasmas to reduce throughput time and increase modeling impact.

  Minimum qualifications:
  - Masters' Degree in Physics, Mechanical Engineering, Material Science, Electrical Engineering or related fields with 8-10 years' experience in modeling and simulation.
  - PhD in in Physics, Mechanical Engineering, Material Science, Electrical Engineering or related fields with 5+ years' experience in modeling and simulation.

  Preferred qualifications:
  - Plasma simulations on commercial packages and plasma codes.
  - Experience with writing codes for numerical simulations of plasmas.
  - Experience with particle, hybrid and fluid formulation of plasmas.
  - Exposure to Multiphysics modeling.
  - Exposure to design of experiments, model formulation and validation.

  To apply: https://careers.lamresearch.com/job/Tualatin-Modeling-Engineer-5-OR-97062/838777200/

  Contact:
  Dr. Meenakshi Mamunuru
  Lam Research Corp., USA
  Meenakshi.Mamunuru@lamresearch.com

Collaborative Opportunities

Please submit your notices for Collaborative Opportunities to iltpc-central@umich.edu.

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